Worksheet 3.1: Conservation in the Galápagos

Introduction

On 24 June 2012, an animal that had been described as the ‘rarest animal on Earth’ died. The animal had been resident at the Charles Darwin Research Centre (CDRC) on the island of Santa Cruz in the Galápagos Islands. It was the last individual of one of the Galápagos giant tortoise subspecies, made famous by their association with Charles Darwin. The tortoise had been discovered in 1972 on the island of Pinta and nicknamed George. He was quickly recognized as the last of his subspecies (*Chelonoidis nigra abingdoni*) – the Pinta Island subspecies. Because he was the last of his kind he became known as ‘Lonesome George’. Scientists estimate he was about 100 years old when he died. Over his time at the CDRC he became a symbol of the Galápagos Islands and the conservation efforts taking place there.

Lonesome George, a Pinta Island tortoise with a saddle-shaped opening to his shell.

Galápagos tortoises

The Galápagos giant tortoise (*Chelonoidis nigra*) is the largest species of tortoise, and the 10th largest reptile on the planet. They can weigh over 250 kg (some up to 400 kg) and have shells measuring up to 1.5 metres, and are believed to live for more than 150 years. The word ‘Galápagos’ is Spanish for saddle, which is the shape of some of the subspecies’ shells on the islands of Española and Pinta. These animals have long limbs and necks for reaching high vegetation. Other subspecies (which represent the larger animals) have a more rounded dome-shaped shell and shorter limbs and necks, and are found on the island of Santa Cruz and around the Alcedo Volcano on Isabela.

Scientists believe that tortoises arrived in the Galápagos Islands by clinging to a piece of driftwood from a river mouth along the Pacific Coast. The closest living relative of the Galápagos tortoise (although not a direct ancestor), the Argentine tortoise (*Chelonoidis chilensis*), lives on the South American mainland. The divergence between *C. chilensis* and *C. nigra* probably took place around 6–12 million years ago, preceding the volcanic formation of the oldest modern Galápagos Islands by about 5 million years ago. Genetic studies show that the tortoises arrived on the oldest islands of the archipelago, San Cristóbal and Española, and then spread throughout the Galápagos Islands. The evolutionary relationships between the subspecies thus echo the volcanic history of the Islands. Those on individual islands or in isolated parts of the larger islands developed into their own sub-species through restricted gene flow, adapting to local conditions in the way described by Darwin. On larger islands such as Santa Cruz, with humid highlands (over 800 metres in elevation), abundant lush grasses allowed the larger high-domed variety to graze. The saddleback subspecies originate from small islands less than 500 metres in elevation with dry, desert-like habitats (e.g. Española and Pinzón) that are more limited in food and other resources. The shell shape and long neck and limbs allow the animals to reach up and feed on plants such as the prickly pear.

Galápagos tortoise with a low shell opening (Chelonoidis nigra).

The voyage of HMS *Beagle*

Charles Darwin visited the Galápagos Islands in 1835 – a 5-week visit during the 5-year voyage of HMS *Beagle* (see pages 156–57 in the textbook). At that time, there were 15 subspecies of the islands’ giant tortoises and there would have been hundreds of thousands of them. The death of Lonesome George marked the loss of an estimated fifth subspecies (three unverified and two recorded), leaving 10 remaining subspecies. Charles Darwin wrote about the Galápagos tortoises in his books and journals, and they had clearly influenced him as he developed his theory of evolution by natural selection. When Darwin arrived at the Galápagos Islands, the vice-governor of the Islands told him that he could identify what island the tortoise was from simply by looking at the shape of the shell and other characteristics. Darwin wrote, in his *Journal of researches into the natural history and geology of the countries visited during the voyage of HMS* Beagle *round the world, under the Command of Capt. Fitz Roy* (1845):

The inhabitants... state that they can distinguish the tortoise from different islands; and that they differ not only in size, but in other characters. Captain Porter has described those from Charles and from the nearest island to it, namely Hood Island, as having their shells in front thick and turned up like a Spanish saddle, whilst the tortoises from James Island are rounder, blacker, and have a better taste when cooked.

Charles Darwin only reported seeing Galápagos tortoises on San Cristóbal (at the time of Darwin’s visit known as Chatham Island) and Santiago (then known as James) Island. The two tortoise subspecies of these islands are *C.* *chathamensis* and *C.* *darwini* calledrespectively. Both have an intermediate type of shell shape and are not noticeably otherwise different from one another. It is unlikely that Darwin would have drawn any useful conclusions to support his theory from these direct observations. At the time, the comments of Captain Porter did not strike Darwin as important – this only came later. Although he had specimens of shells from two islands, he had mixed these up and not recorded which shell had come from which island. On leaving the Galápagos, the ship had 30 adult tortoises on deck but these were not for scientific study – they were a source of fresh meat for the Pacific crossing. Their shells and bones were thrown overboard, leaving no remains with which to test any hypothesis. It was only on reading his notes and combining the evidence of the tortoises with those of other animals that Darwin started to use them in the formulation of his new theory (see pages 156–58 in the textbook). He wrote in one of his research notebooks (Notebook B, ‘Transmutation of species’):

'Animals on separate islands ought to become different if kept long enough apart with slightly differing circumstances. – Now Galápagos Tortoises, Mocking birds, Falkland Fox, Chiloé fox, – English and Irish Hare.'

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| Tortoise facts |
| • Poachers threaten Madagascar's rare tortoises, which include the ploughshare, spider, radiated and flat-tailed species. |
| • Radiated tortoises are ‘one of the world's most beautiful species’, according to Sir David Attenborough. They are only found in southern scrublands in Madagascar. |
| • Burmese starred tortoises are also listed as critically endangered (IUCN Red List). They get their name from the striking yellow and dark brown star pattern on their shells. |
| • Kleinmann's tortoise, also known as the Egyptian tortoise, is the smallest of the Mediterranean species. |

The leopard tortoise (Stigmochelys pardalis) is found in southern and eastern Africa.

Conservation in the Galápagos

For thousands of years, the tortoises enjoyed life free from predators. They were ideally suited for life in the Galápagos Islands, whose sometimes barren terrain enabled them to survive with little food and water during times of drought. The arrival of adventurers, whalers and fisherman led to tortoises being hunted as a source of meat and oil. At the same time, these new arrivals brought pigs, goats, horses, and cows, which ate the local vegetation and crushed tortoise eggs and the soft shells of young tortoises. Before the arrival of humans, Pinta Island, located in the north of the archipelago, was home to thousands of tortoises. Initially, female tortoises were collected as they were smaller and easier to handle. When the females became scarce, males were also collected, depleting the population still further. During the 1950s, fishermen working the nearby waters used the Islands to restock their meat supply while at sea. Since tortoises were no longer available, they released feral goats, which quickly multiplied and took over the island, devouring the little vegetation that existed. By 1972, the tortoise population had dwindled to one adult male – Lonesome George.

In 1959, the Charles Darwin Foundation (CDF) was created, and the Galápagos National Park established. The CDF was established to carry out research for the conservation of Galápagos ecosystems, to educate visitors to the Islands about natural history and issues concerning the Islands, and allow visitors to see the tortoise-breeding project at work. More than 100 scientists, students and volunteers work with research and conservation projects to protect the Galápagos Islands and their endangered species. In 1964, the Charles Darwin Research Centre (CDRC) was established on the island of Santa Cruz, which is where Lonesome George spent the last 40 years of his life.

In 2007, UNESCO put the Islands on its World Heritage danger list, citing threats posed by invasive species, unchecked tourism, and overfishing. With 185 000 visitors in 2011, it is clear that the Galápagos will never be the pristine wilderness it once was. However, it is hoped that careful control of tourism and removal of invasive species will help stop other species on the Islands following Lonesome George into extinction.

Breeding programme

The Ecuadorian park service kept George at the CDRC, where he became part of the Galápagos National Park Breeding Programme. Scientists made every effort to encourage him to breed with female tortoises from Wolf Volcano on Isabela (Wolf tortoises are the closest morphologically and genetically to the Pinta tortoises). In July 2008, tortoise eggs were discovered in the pen that George shared with his female companions, although it was discovered that the eggs had not been fertilized and so could not develop. Despite the lack of success in re-establishing a population of Pinta tortoises, the conservation efforts in the Islands have resulted in the overall population of Galápagos giant tortoises growing to around 20 000, from a low in the 1970s of a few thousand. The [Hood Island subspecies](http://www.iucnredlist.org/apps/redlist/details/9024/0) has recovered from a low of 15 to more than 1200. Nevertheless, the species is still classed as ‘[vulnerable](http://www.iucnredlist.org/apps/redlist/details/9011/0)’ by the International Union for Conservation of Nature (IUCN).

A new beginning?

Tortoises living around Wolf Volcano on the Galápagos island of Isabela are hybrids and have genes from several subspecies. This [interbreeding has been caused by whalers and pirates](http://www.newscientist.com/article/mg19426071.300-galapagos-tortoises-untangling-the-evolutionary-threads.html), who dumped tortoises on Isabela. These hybrid tortoises preserve genes from several subspecies thought to be extinct, including Pinta Island tortoises. So the very people who ate and introduced invasive species to the Islands may have inadvertently left a solution for the re-establishment of the subspecies, thus saving the animals from extinction.

At the University of Chicago in Illinois, scientists have begun sequencing Lonesome George’s genome – this will help identify tortoises that carry Pinta genes. A team of scientists is currently sampling tortoises from the region and looking for animals that carry Pinta DNA. In theory, by selectively breeding tortoises with the Pinta genes, a new population of the subspecies could be created. However, the slow reproduction rate of tortoises make it likely that such a breeding programme would take many decades.

Further reading

*Lonesome George: The Life and Loves of a Conservation Icon*, by Henry Nicholls. Published by Macmillan Science (2006)

For further information and useful resources to support this worksheet, go to [www.pearsonhotlinks.com](http://www.pearsonhotlinks.com), enter the book title or ISBN, and click on ‘Worksheet 3.1’.

Questions

**1** Define the term ‘species’. *[1 mark]*

similar organisms living together than can interbreed.

**2** List three causes of isolation that that can lead to different species being produced. *[3 marks]*

barriers, distance, separation

**3** Give one example for each of the isolating mechanisms listed in question 2. *[3 marks]*

mountains, genetically differentiated dolphins cannot mate, mating within communities only

**4** Outline the mechanism of natural selection as a possible driving force for speciation. *[5 marks]*

some species die out, and the ones fit to carry the genes for the future live, deciding the outcome of the next generations

**5** Outline the role of plate activity on speciation. *[4 marks]*

movements can cause isolation of species and making them change, bring in competing species together

**6** Other than the reasons illustrated by the case of the Galápagos giant tortoise, what factors
can cause species to become endangered or extinct? *[4 marks]*

human interactions, pollution, destruction of habitat, competition, adaptations, natural selection.